CLAIMS

I claim:

1. A hydrogen generator-fuel cell apparatus, comprising:
   a) a reaction chamber;
   b) means for providing heat input into said reaction chamber;
   c) a catalytic material for decomposition of hydrocarbons;
   d) means for storing and introducing a hydrocarbon fuel into said reaction chamber;
   e) a hydrogen selective membrane for purifying hydrogen produced in said reaction chamber;
   f) a fuel cell containing at least one electrochemical cell;
   g) the electrochemical cell having an anode and a cathode separated by a membrane; and
   h) an outlet for delivering hydrogen from said reaction chamber to said fuel cell.

2. The apparatus of claim 1, wherein said catalytic material is a high surface material greater than about 1 m^2/g.

3. The apparatus of claim 2, wherein said catalytic material is activated carbon having surface area higher than about 100 m^2/g.

4. The apparatus of claim 1, wherein said catalytic material contains a dopant for hydrocarbon desulfurization.

5. The apparatus of claim 4, wherein said dopant is ZnO.

6. The apparatus of claim 1, wherein said means for hydrocarbon storing is a hydrocarbon-soaked ceramic fiber.

7. The apparatus of claim 1, wherein said hydrogen selective membrane is chosen from one of: Pd and Pd-Ag.

8. The apparatus of claim 1, wherein said hydrogen selective membrane is a ceramic.

9. The apparatus of claim 1, wherein said fuel cell is a polymer electrolyte fuel cell.

10. The apparatus of claim 1, further comprising:

an inlet for charging said catalytic material into said reaction chamber and dislodging carbon product from said reaction chamber.

11. The apparatus of claim 1, comprising additionally an insulation between said reaction chamber and said fuel cell.

12. A hydrogen generator-fuel cell apparatus, comprising:

a) a reaction chamber;

b) means for providing heat input into said reaction chamber;

c) means for storing and introducing a hydrocarbon fuel into said reaction chamber;

d) a first layer of catalytic material for decomposition of said hydrocarbon fuel;

e) a second layer of catalytic material for increasing hydrogen concentration in the first layer and production of filamentous carbon;

f) a fuel cell containing at least one electrochemical cell;

g) said electrochemical cell containing an anode and a cathode separated by a membrane; and,

h) an outlet for delivering hydrogen from said reaction chamber to said fuel cell.

13. The apparatus of claim 12, wherein said first catalytic material is an activated carbon with a surface area higher than about 100 m^2/g.

14. The apparatus of claim 12, wherein said first catalytic material is an activated alumina with a surface area higher than about 100 m^2/g.

15. The apparatus of claim 12, wherein said upper catalytic material is Fe-based catalyst.

16. The apparatus of claim 12, wherein said upper catalytic material is Ni-based catalyst.

17. The apparatus of claim 12, wherein said first catalytic material contains a dopant for hydrocarbon desulfurization.

18. The apparatus of claim 17, wherein said dopant is ZnO.

19. The apparatus of claim 12, wherein said means for hydrocarbon storing is a hydrocarbon fuel soaked ceramic fiber.

20. The apparatus of claim 12, wherein said fuel cell is a polymer electrolyte fuel cell.

21. The apparatus of claim 12, further comprising:

an inlet for charging said catalytic material into said reaction chamber and dislodging carbon product from said reaction chamber.

22. The apparatus of claim 12, comprising additionally an insulation between said reaction chamber and said fuel cell.

23. A compact and portable integrated hydrogen generator-fuel cell apparatus, comprising:

a) a reaction chamber;

b) means for storing and introducing a fuel into said reaction chamber;

c) a high temperature fuel cell which is thermally and spatially integrated with said reaction chamber;

d) a catalytic material for production of gaseous fuel for said fuel cell in said reaction chamber;

e) a compressor for recirculating gaseous products between said reaction chamber and said fuel cell;

f) said fuel cell containing at least one electrochemical cell;

g) said electrochemical cell containing an anode and a cathode separated by a membrane; and

h) a connector for delivering gaseous fuel from said reaction chamber to said fuel cell.

24. The apparatus of claim 23, wherein said catalytic material is an activated carbon with a surface area higher than about 100 m^2/g.

25. The apparatus of claim 23, wherein said catalytic material is Fe-based catalyst doped with K_2CO_3.

26. The apparatus of claim 23, wherein said catalytic material contains a dopant for hydrocarbon desulfurization.

27. The apparatus of claim 26, wherein said dopant is ZnO.

28. The apparatus of claim 23, wherein said fuel is a liquid hydrocarbon fuel.

29. The apparatus of claim 28, wherein said means for hydrocarbon storing is a hydrocarbon fuel soaked ceramic fiber.

30. The apparatus of claim 23, wherein said fuel is petroleum coke.

31. The apparatus of claim 23, wherein said fuel is a biomass.

32. The apparatus of claim 23, wherein said fuel is coal.

33. The apparatus of claim 23, wherein said fuel cell is a solid oxide fuel cell.

34. The apparatus of claim 23, wherein thermal initiation for the production of gaseous fuel is provided by a rechargeable battery.

35. The apparatus of claim 23, wherein said reaction chamber and said fuel cell are contained within an insulated structure.

36. The apparatus of claim 23, further comprising:

an inlet for charging said catalytic material into said reaction chamber and dislodging carbon product from said reaction chamber.

37. Carbon particles having surface filaments comprising in combination:

an approximately one micron diameter in average;

an "octopus"-like structure, with a portion of the structure being substantially hollow, and each filament being substantially of longitudinal uniformity and of graphitic structure.

38. The carbon particles of claim 37, having a property of oil film adsorption from a surface of water.

39. The method of producing carbon particles having surface filaments of about one micron mean diameter, an "octopus"-like structure with a hollow portion, and longitudinal uniformity, of graphitic structure, comprising the steps of:

a) passing electrical current through carbon-based catalytic material and heating it to about 850 to about 1200°C;

b) passing a stream of hydrocarbon fuel through said carbon-based catalytic material with production of hydrogen-rich gas and carbon with filamentary surface deposited on the surface of said catalytic material; and:

c) recovering carbon particles with a filamentary surface.

40. The method of claim 39 wherein said carbon-based catalytic material is carbon black and heating is to approximately 1000°C.

41. The method of producing carbon nanofibers, comprising the steps of:

a) providing a first layer of catalytic material for decomposition of said hydrocarbon fuel;

b) providing a second layer of catalytic material for increasing hydrogen concentration and production of carbon nanofibers;

c) heating said first and second catalytic layers to about 600 to about 1000°C;

d) passing a flow of hydrocarbon fuel through said first and second catalytic layers; and,

e) recovering said carbon nanofibers.

42. The method of claim 41 wherein said second catalytic material is Fe-based catalyst.

43) The method of claim 41 wherein said second catalytic material is Ni-based catalyst.